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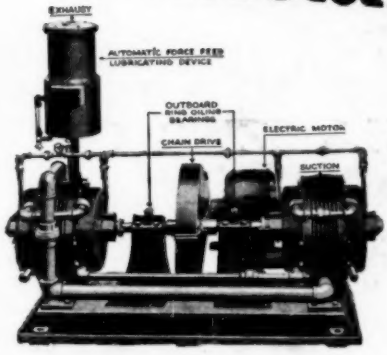

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OIL & FAT INDUSTRIES. Vol. V. No. 8. August, 1928. A monthly journal published by Russell Palmer at 420 Madison Ave., New York, N. Y. Subscription, $3.00 the year, domestic; $4.00, foreign. Entered at the Post Office, N. Y., Dec. 31, 1925, as second class matter under act of March 3, 1879.

OIL & FAT INDUSTRIES

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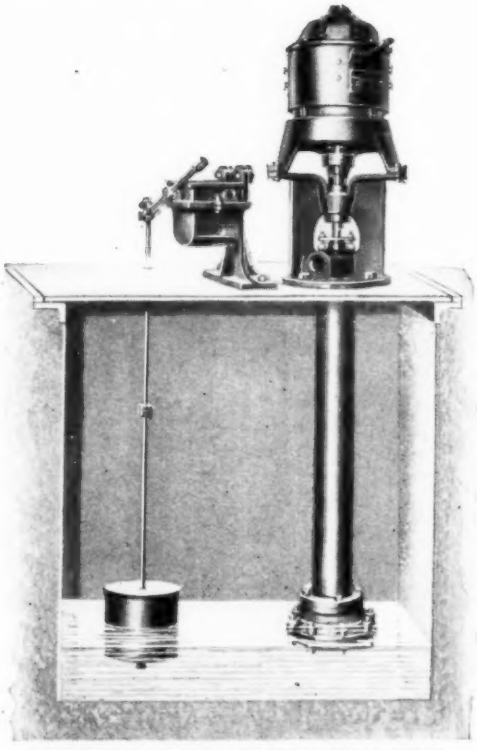

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OIL & FAT INDUSTRIES

VOLUME V AUGUST, 1928 NUMBER 8

Cooperation Fosters Efficiency

Editorial

THE cottonseed crushing industry as a whole has definitely decided to march forward into that place of business leadership among Southern activities to which it is entitled by virtue of its volume, but which, because of loose organization, it has never fully occupied.

During the month just past, the crushers have taken two courageous and important steps looking toward increased success and prosperity for everyone in the industry.

The first of these was the meeting of a joint committee of the Interstate and Texas Cottonseed Crushers' Associations at Memphis, July 20 and 21. This meeting adopted resolutions and principles which will undoubtedly lead to the formation of a unified National Association of oil millers, with definite aims for the betterment of their business.

The second forward step of the month was taken at a conference between representatives of the entire industry and members of the Federal Trade Commission.

At this conference a "Code of Ethics" was agreed upon, which is calculated to put an end to any abuses and unfair practices formerly prevalent, particularly in the purchase of seed. We cannot refrain from quoting the following from the preamble to this Code:—

"They—(the oil mills)....owe a duty.....That duty includes the *obligation* to....deal fairly with labor, to *manufacture efficiently*, to *eliminate waste*...., to *condemn* and *prevent bad practices*." (The *italics* are ours.)

In the August issue of "The Cotton Oil Press" there appears an excellent report by John P. Harris and B. F. Glick, giving the results of value of 1% achieved by FIL-7,000,000 pounds of cottonseed oil. This report shows an improvement of value of 1% achieved by FILTRATION of oil which was already better than prime when it came from the presses.

We have repeatedly advocated filtration of crude cottonseed oil and we heartily recommend this report by Messrs. Harris and Glick, in the August issue of "The Cotton Oil Press" to the attention of all oil millers who desire to live up to the letter of the new Code of Ethics by *manufacturing efficiently, eliminating waste*, and *preventing bad practice*.

Ramifications of the Oil Industry

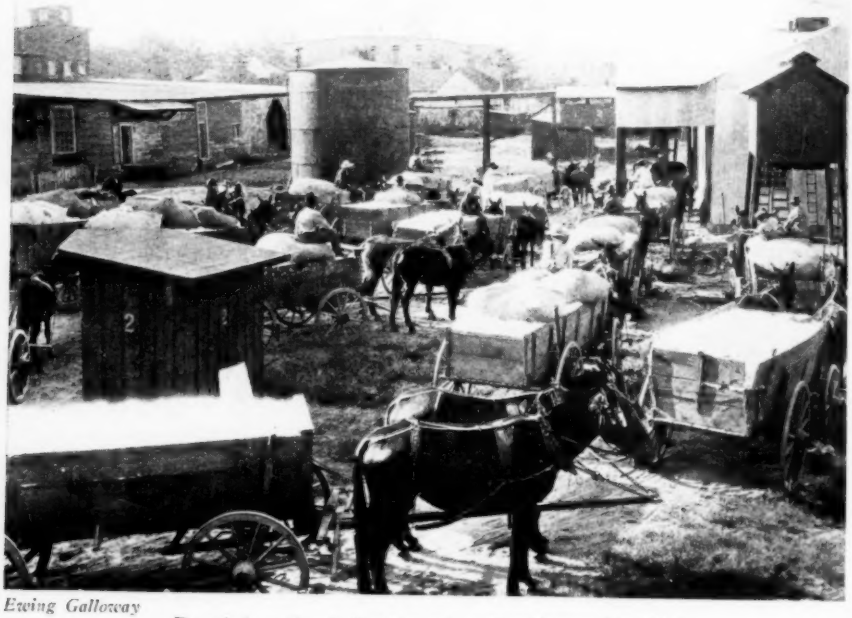
(Part 1.) Processes.

BY THOMAS ANDREWS

THE raw material of the Oil and Fat Industries, as it is received into the mills, consists, essentially, of the oleaginous material from which the required oil or fat may be obtained, but with it we find various impurities of which the most important are:—

1. Moisture.
2. Dirt and adhering dust.
3. Metallic impurities.

After weighing the material at the mill, the first process consists of removing, as far as is commercially possible, these impurities from the bulk. Outweighing, in its possible effects, the other impurities is the moisture, because in the presence of the enzymes contained in the seed, this produces hydrolysis with a consequent formation of free fatty acids. Moreover, under favorable conditions of storage, oxidation of these and of the freed glycerol can take place. When it does we find an oil that is high in free fatty acids and rancid. Our first thought, therefore, must be directed to seeing that the seed is well ventilated, and stored under loose conditions as far as possible, as dry as possible, and so arranged that the maximum amount of air can circulate through it in the bulk.



Ewing Galloway

Receiving Seed Cotton at a Southern Oil Mill

In dirt and adhering dust remov-

al we nullify the effects of the close confinement that our oily material has suffered in transit. Should it be desirable to remove matter larger than the seed, then the material is fed through revolving screens, the mesh of which will allow the seed to fall through, but not the larger impurities. A screen which will retain the seed and allow the dirt and dust to pass through is next used. When blowers are fitted to these screens a very valuable double effect is obtained although this is not always intentional nor recognized. I refer to the thorough ventilation that the seed obtains while rolling around in a screen through which a current of air is passing. Introduced in the first instance to thoroughly remove the dust and dirt, to allow the marketing of a pure cake, there is no doubt but that this thorough ventilation is of great value from the point of view of good quality oil.

The removal of pieces of iron and steel presents very little difficulty. Permanent magnets or electromagnets are placed in the path of the material prior to its entry into any machine and these metals are removed. There generally remains a small proportion of material approximating the seed in size that is removed only with difficulty. Generally, where desired, it is removed by hand during a portion of the seed's preliminary journey when it is thinly spread, as when traveling on a belt.

The purified bulk is then placed in silos for storage.

Methods of Winning Fatty Values

We may classify the various methods of obtaining the oil or fat under the following headings:

1. Dry rendering.
2. Digestion with steam or hot water.
3. Expression.
4. Extraction with solvents.

These processes are being worked in many ways. We still have instances of oil obtained by natives using the primitive methods of their forefathers competing with the same oil obtained by a staff of highly trained technicians working elaborate machinery under modern conditions.

In the case of those oils obtained from seeds and nuts having an outer shell or covering, it is often necessary to remove this covering before the operation to recover the oil can be used. In the removal of these coverings there are great obstacles to be overcome and a great deal of ingenuity has been expended in designing machinery for this purpose. There is no doubt but that the oil trade has progressed as and when machinery has been adopted to do this work. Without the invention of the "linter"—a machine for removing the fine cotton fibre adhering to some classes of cottonseed—the present American cotton oil trade might have languished and possibly even perished instead of becoming the leading cottonseed trade of the world. These coverings vary considerably and, as a corollary, no one machine can handle the whole, but must be, and is, designed to carry out one particular work. For example coconuts have to be freed from a thick, hard, hornlike cover, and the groundnut, after it has been shelled in one machine, has still a thin, tissue-like, soft skin that is often removed. Between these two we have practically every type of covering to remove, requiring much time and effort to design machines to carry out this work.

Having removed the outer covering from the oil-bearing material the next process consists of pre-

paring the kernels or "meats" for the recovery of the oil. Those materials the next process for which consists of rendering or digesting are minced to a moderate fineness, and nothing more, the heat and moisture incidental to the process being allowed to break down the tissue holding the oil cells. With those materials however that are to be pressed or extracted, the oil cell is broken down. To do this the "meats" are subjected to very fine rolling and grinding accompanied by a tearing action. The "meats" to be pressed are further treated with heat and moisture—tempered, as it is called—to further break down the oil cells, with the result that the oils are freed from the container in which nature has placed them and are consequently more easily removed by pressure.

Dry rendering is chiefly used in connection with animal and fish tissue whenever oil forms the bulk of the raw material and whenever the moisture content is high enough to cause a breakdown of the fat cell on heating. This applies to suets, meat fats, blubber, bones and to certain fresh fish livers.

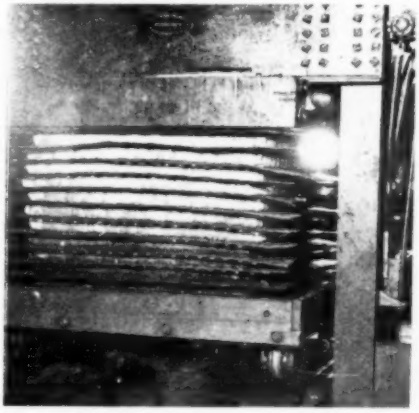
Digesting either at high or low pressures is resorted to in the case of similar material as is used in rendering, in those cases where hydrolysis is not of paramount importance. Digesting differs from rendering in that water, in some form or other, comes into intimate contact with the fatty material. The product is of a lower grade than that obtained under a first class dry rendering process but the process has certain well defined advantages. In the case of putrefied animal and fish tissue it is often the only commercial method of obtaining the oil or fat in a marketable condition, for it is possible by this method both to obtain the oil and at the same time

Ewing Galloway

Primitive Methods of Pressing Sesame Seed in India

partially deodorize it. This is accomplished by digesting at high steam pressures and by releasing the pressure at stated intervals during the run. This method is also resorted to in obtaining the oil from palm fruit, and a melange of pressing and digesting is often used in the manufacture of inferior olive oils. In both the above processes the oil is removed by skimming the surface of the mixture left after settling. In the case of dry rendering, the tissue lies at the bottom of the pan as a somewhat moisture free mass containing up to 50% of fat. This material is treated in a press to remove the bulk of the remaining oil or fat and the cake is sold for poultry feeding or similar purposes under the name of greave cake. In the case of digesting, the residue consists of a wet mass of tissue and fibre which is generally dried to produce meals for fertilizers.

Expression consists of exerting power in such a way that the liquid oil is expelled from the solid matrix. The hydraulic press is the machine most commonly used for this purpose. It consists essentially of a ram that rises within a cylinder when acted upon by a fluid under pressure. In rising it is made to transmit its pressure to material between it and a fixed plate. In the older forms of presses the pressure under the ram was transmitted to a series of plates free to rise with the ram and containing between each pair an envelope filled with the "meats" to be treated. The oil that was pressed out ran down into a gutter from which it was carried to the store tank for further treatment. The cake was removed from the press in its envelope. This was removed and, after the oily edges of the cake had been peeled away, the cake formed the chief source of the majority of cattle foods and fertilizers of vegetable origin. A more modern form of the hydraulic press is that one in which the envelopes are not used, a finely divided or perforated box or cage taking the place of them and extending for the full space between the ram and the head of the press. The comminuted tempered meal is placed within the box or cage in definite charges and metal plates are used to divide each charge, thus doing away with the



Ewing Galloway

Pressing Seed Oil in the Pribilof Islands

envelopes. Pressure is applied direct to the charges within the cage. The oil is discharged out of the minute divisions or perforations. The cakes from this type of press do not require paring of their edges, although they are similar in other respects to the cake obtained from those presses using porous envelopes. As the pressures which can be applied to the cake in this form of machine are often very high, we find that in the endeavor to obtain very good yields of oil some crushers are in the habit of turning out a hard cake. Consequently, from a cattle feeding point

of view, these cakes are considered inferior to the others—but there is no reason for their being so.

The screw press in which the action of a worm propeller presses the meal against some obstruction, thus accumulating the pressure, also is used for removing the oil, which flows through minute orifices in the worm box. This is built in a similar manner to the cage of the latter type of press considered above. It yields a meal and an oil as against a cake and an oil in the case of the press. With these expellers, however, there is generally a comparatively large proportion of foots. These consist of a suspension of very fine meal in oil, and owing to the fact that the meal is practically in colloidal suspension in the oil, its separation is a very difficult problem. In such a foots obtained when treating groundnuts the oil content exceeded 45%.

Solvent extraction, as its name implies, is a method used for removing the oil by dissolving it out by a solvent, leaving the solid material behind. The material to be extracted, in a properly pulverized condition, is fed into a closed tank through a suitable charging door. The door is then closed and the solvent is passed into the meal in such quantities that there is a considerable surplus over the amount needed to saturate the meal. After the solvent has remained for a short time in close contact with the meal, this surplus is withdrawn and the remaining meal is washed with further quantities of solvent until the oil content has been removed to the requisite amount. The solvent containing the oil is removed to a still where the former is distilled off leaving the oil behind. The solvent is passed as a vapor through a series of condensers where it is recovered for further use. The solvent saturating the meal is removed by open steam, condensed, and after being separated from the water, which is condensed with it, is returned to the store tank with the solvent from the still. The oil in the still is freed from traces of the solvent by open steam, and both it and the meal are discharged. The meal, after drying, is used for the same purposes as the cakes from the press, although owing to its lower oil content certain modifications have to be allowed for.

Uses of the Products

By using one or more of the above processes we have our oil free from solid meal and our meal free from liquid oil. As we have seen, the solid material, irrespective of the method adopted, may give us either a fertilizer or a cattle cake or meal. The origin and condition of our raw material largely determines the final use of the residue—foods in the case of the non-injurious and fertilizer in the case of the putrid or poisonous. When it is desired to use these materials as fertilizers they are finely ground, but the cakes to be used for cattle food may be sold in the condition in which they are received from the presses. The meals which contain too high a proportion of moisture to meet the market conditions are dried in some form of drier. To market the meal for cattle food, other than for feeding pigs, it is usual to further treat it in some way so as to make it more easily and efficiently fed to the animals. With this further operation it is usual to arrange such blendings and additions to the meal as will make the food more balanced or more appetizing. The meal is fed into a kettle similar to that used in heating and tempering for pressing

and, while it is being treated, the whole is agitated with such spices, sugars, binding materials, diluents or additive materials as will, in the opinion of the blender, give the desired food. The whole is then thoroughly mixed and warmed, the warming or cooking having the twofold object of bringing the starchy material into a "binding" condition and of liberating the cyanogen radical from the glucocyanides that are present in some seeds. The material is then forced by pressure either into moulds or through dies where it forms a convenient and handy form of cattle food in the shape of nuts or cubes.

With *oil* containing a more or less high proportion of meal it often is necessary to remove the solid impurities at the earliest moment, and in the case of those oils which are to be used for edible purposes *no time should be lost* in doing this. In some mills this is done by settling in tanks or by centrifuging, but in most modern mills the oil is filtered as soon as it comes from the presses or other plant. This oil constitutes the raw or crude oil of commerce.

Classifications of Oils

These oils, for our purpose, may be classified into three main divisions:—

1. Drying oils, namely those oils which are capable of absorbing oxygen from the air and forming more or less elastic skins when exposed in thin layers.

2. Semi-drying oils, namely those oils which, while still capable of absorbing oxygen from the air, do so to a modified extent and are not capable of forming a firm skin under normal atmospheric conditions.

3. Non-drying oils, namely those oils which do not absorb oxygen from the air under normal conditions and which are not capable of forming a skin.

These definitions are more or less fixed by common usage in the chemistry of oils, and although they are open to serious objection from many points of view I will use this classification on which to base the uses of the oils from a process point of view.

Uses of Drying Oils

As the name implies the chief use of the drying oils is to prepare products capable of forming a skin. These oils will form a skin when exposed to the air without any preliminary treatment but in the desire to speed up this process of oxidation we have the foundation of the "boiled oil industry."

In the latest methods the oil to be "boiled" (quite a misnomer by the way) is heated to a temperature of about 150°C together with a small proportion of lead or manganese salts—the so-called driers—with or without the passage of an air current, the length of time that is taken determining the quality of the oil both with regard to its color and its drying properties. The peculiar reaction that occurs causes the oil to skin when laid in a thin film in hours instead of in days as a thin layer of the raw oil would need. The actual *modus operandi* of the process is simple but the underlying reaction is not fully understood to this day. At one time it was thought that the speeding up was due to the absorption of the oxygen during the boiling of the oil but as oils can be prepared, after boiling, with the same iodin value as they had previous to the boiling, this view cannot be accepted. The view that in the boiling the metallic driers become converted into metallic soaps

which act catalytically in the drying of the boiled oil is still open to proof because if we add lead linoleate (the salt which would be formed on boiling convertible lead salts with commercial linseed oil) to linseed oil in the cold the resulting oil is not speeded up as would be the same oil on boiling. Moreover this oil with the addition of the salt *is* speeded up if we raise its temperature to something over 120°C. Personally I subscribe to the view that a small proportion of a polymer is formed—possibly crystalline—capable of being itself oxidized and creating a further supply of polymer in so doing. To make this perhaps a little clearer I would refer to the oxidation of coal. Coal is capable of burning (oxidizing) and at the same time it is capable of bringing raw coal in its immediate neighborhood into a condition for rapid burning or rapid oxidation. This analogy, while not perfect, will give you some idea of the automatic oxidation which takes place. Linseed oil is practically the only oil which lends itself to the process of boiling although other oils of high iodin values can be, and sometimes are used, but unless the high iodin value is associated with the presence of an appreciable amount of linolenic acid in the oil it cannot truthfully be said that the oil is a "boiling oil."

It is usual to refine the linseed oil that is to be boiled, to remove the mucilage, organic salts, moisture and other impurities which might otherwise spoil the oil during the process of boiling. This is particularly important in the case of those boiled oils which are to be used later for mixing with gums at high temperatures to form varnishes. The boiled oils find a ready outlet in the manufacture of paints, varnishes and enamels. A paint is, essentially, a levigated pigment ground in boiled oil to a homogeneous mass free from grit. To prepare this paint for application this ground mass is thinned out with more boiled oil, turpentine and, in some cases, with petroleum products. In the case of paints the pigments are not in solution in the boiled oils and this is the chief difference between a paint and a varnish. A varnish consists of a gum or resin dissolved in boiled oil. Gums in their raw state, do not dissolve readily, if at all, in boiled oil. After fusion, however, at temperature of 300°C and over their solution in boiled oil, while still brimming with difficulties, can be accomplished. Thus the first operation in the manufacture of varnishes consists in heating the gums to such temperatures as to make them soluble in the boiled oil. During the heating the gums lose weight and the manufacture of varnishes, from the efficiency point of view, largely consists in heating the gum to the soluble condition with a minimum loss in weight. After the solution of the gum in the boiled oil the varnish oils are settled or filtered. They are then thinned by the addition of oil of turpentine till they are in the right condition for applying. This addition of turpentine is likely to cause a fog or a bloom in the varnish unless the gum and the boiled oil are in the right condition. If, instead of thinning the varnish oil, pigments had been ground into it, the well known enamels would have been formed. These are thinned in the same way as paint for use.

When we come to consider the action of air and heat on the semi-drying oils we find that they can be oxidized as well as the drying

oils but they yield a different class of products. These are the well known soluble, thickened or blown oils. Air is blown into the raw semi-drying oil as a fine spray, the oil being kept steady at the predetermined temperature, generally between 75°C and 110°C. At the same time the air is kept in motion in some manner so that intimate contact is made between the oil and the air. As the absorption of the oxygen is accompanied by evolution of heat it may be necessary to keep the temperature of the oil from rising during the reaction. During the reaction the oil rises in specific gravity and attains a high viscosity. At the same time volatile decomposition products are given off which require to be removed as in the presence of absorbent material they are likely to cause spontaneous combustion. Owing to their high gravities, high viscosities and miscibilities with mineral oils these are sometimes sold under the name of "soluble castor oil" although they have no relationship to castor oil at all. They can, however, be easily recognized from castor oil owing to their very poor solubility in alcohol.

Ewing Galloway

Mixing Putty in Which Linseed Oil is the Base

The oils which are chiefly used in this process are rape, cottonseed, maize, seal and whale oils. The oils, where necessary, having been freed from the solid tri-glycerides by a process that I hope to refer to later, the blown oils are used (blended with mineral oils) for lubricating purposes although their tendency to gum and their

low flash points preclude their use under certain conditions. The blown oils also find a use in the leather-curing industry, in fact, at one time this was their only outlet.

Linoleum Manufacture

If instead of blowing the semi-drying oils we had started with linseed oil, or better still, blown linseed oil we should have found that this oil behaves in the same manner and is capable of absorbing large quantities of oxygen and, if we had carried the experiment far enough, we should have found that at ordinary temperatures the product was quite solid. This oxidized boiled oil is prepared on a very

Ewing Galloway

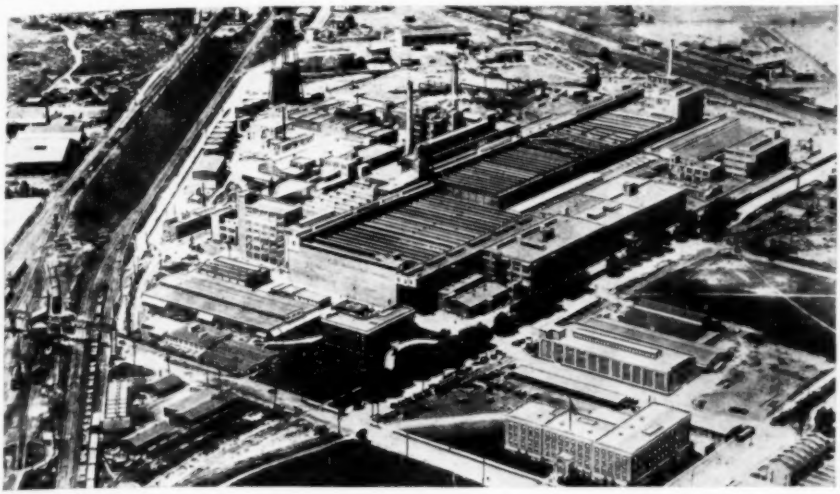
Interior View of Linoleum Oxidizing Tower

large scale commercially and forms the body for the preparation of linoleums. The linseed oil is oxidized in a variety of ways the best of which is known as the "scrim" process. Here the boiled linseed oil is allowed to flow at a moderate temperature down a layer of fine cotton fabric suspended in a lofty building and the oil reaching the bottom is re-circulated over and over the fabric until it gives a thick layer of solidified linseed oil on either side of the fabric. The solidified oil can be made in a plant similar to that used in the blowing of the semi-drying oils but the resulting product is considered inferior to that produced by the "scrim" process. This solid oil mixed with varying proportions of kauri gum, cork dust, resins and similar material (with various bodies and pigments) backed on to a jute fabric forms the "floorcloths", "linoleums," "cork linoleums" and similar substances that are so well known to all of my readers.

The close resemblance that sulphur bears to oxygen—chemically—will no doubt have caused some of you to wonder whether the above reactions between oils and oxygen have their counterparts with oils and sulphur. Surveying the chemical reactions of oxygen and sulphur with the same bodies we can formulate the general rule that sulphur will react similarly to oxygen but at a slower velocity. This rule holds true in the oil world. Where the reaction of oils with oxygen are rather violent, the reactions with sulphur, if I may use the word, are dignified, and where oxygen does actually clutch the body with heat, sulphur will just shake hands as it were. Therefore as we may expect at elevated temperatures sulphur forms analogous bodies with oils to the various oxidized oils. These bodies are solid and semi-elastic and can therefore be used as substitutes for rubber. The oils most suitable for this process are rape, maize, sesame, and soya.

Looking over the above, we find

the processes that we have considered up to this point are all additive processes, that is to say processes where something is actually added to the oil molecule without destroying the molecular structure. Under this same classification we may include the hydrogenation of oils, or, as it is more commonly called, the hardening of oils. As you must all be aware had we added oxygen to the oil in such a way as to destroy the structure of the oil we should have burnt the oil and our final products would have been carbon dioxide and water. As you well know some of the acids in the fatty acid world have some of their carbon content in a condition in which it can make an alliance with one or more atoms of another element without in any way upsetting the structure of the compound and without disturbing its own position in the linkage. As the normal element that should be present in these positions is hydrogen those carbon atoms which have not their complete number of hydrogen atoms attached to them are said to be unsaturated. If we can arrange to give these atoms their full complement of hydrogen we are said to have saturated the compound. This is what we do in the hydrogenation of oil. As the saturated oils and fatty acids are solid at ordinary temperatures, the term "oil hardening" has consequently arisen.



Ewing Galloway

Aeroplane View of a Large American Linoleum Factory

Oil and hydrogen in their ordinary condition have no great affinity for one another but by bringing an unsaturated oil and hydrogen together in the presence of a catalyst we can cause the hydrogen to fill the vacant positions in the carbon bondings. On a works scale the hydrogen is brought into intimate contact with the oil in the presence of finely divided nickel which has been freshly reduced from its oxide. Under these conditions the hydrogen penetrates the molecule and a saturated molecule is obtained. The degree of complete saturation will depend on the proportion of car-

bon atoms which receive their full numbers of hydrogen atoms, thus by varying the proportion of hydrogen absorbed we can obtain fats of varying hardness.

Practically all the unsaturated oils are suitable for hydrogenation although, price being equal, it will pay better to saturate those which will absorb the less quantity of hydrogen for a given hardness. Whatever oil of the unsaturated series we start with, we must finish with oils containing only the "stearic acid" group if we continue the saturation to its final end. In ordinary terms then our final product will be something in the nature of mutton tallow. These tallows, being largely the product of the animal kingdom, are limited in nature, whereas the oils of the vegetable world are abundant, and in that we are able to make the less abundant from the more abundant lies the value of oil hardening. As a natural corollary it follows that as the animal fats become scarcer so the value of hydrogenated fats must increase. Since there are no natural oils or fats with an iodin value of zero it is possible to hydrogenate all of them. These products find an outlet in the edible oil trade, the soap industry and in the candle industry.

Substitutive Reactions

Passing from this survey of the oil industry as far as the additive products are concerned we come to that part of the industry where we add some body to the oil at the expense of a body already forming part of the oil. Oils are essentially "organic salts" or to give them their proper name "esters." A true oil is the ester of the alcohol "glycerol" and one of the higher fatty acids. When the fatty acid is in combination with another alcohol that ester is termed a wax. Glycerol is a tri-hydric alcohol and therefore combines with three molecules of the fatty acid to form the neutral oil. Following the usual law of chemistry it should be an easy matter to displace the glycerol radical by a stronger base and thus form a salt of the fatty acid. This is done commercially on a very large scale and is the principle underlying the manufacture of those commodities we call "soaps." From the above definition it will readily be seen that technically a soap is a combination of a fatty acid and a base but in common parlance we refer to the water soluble combinations only as soaps. The soaps of this class are the salts of sodium, potassium and ammonium with any of the higher aliphatic acids. The fatty raw material can be furnished by any of the natural occuring oils and fats or by fatty acids obtained from them by a preliminary treatment by other processes. The oil and the base must be selected with great care as no two oils or fats give the same identical soap and the choice of the base determines whether the soap will be "hard" or "soft." Potassium soaps are invariably soft soaps and sodium soaps are invariably hard soaps, but here again all soaps of potassium are not equally soft and all soaps of sodium are not equally hard. Broadly speaking, whatever base is used, the softness of a soap is in direct relationship to the iodin value of its constituent oils; the higher the iodin value the softer the soap.

There are two chief soap-making processes in use today on a manufacturing scale, called respectively; the "hot process" and the "cold process." There are certain classes of fats belonging to the coconut

oil group which readily combine with caustic soda with the elmination of the glycerol to form a soap at low temperatures. Provided great care is taken it is not a difficult matter to prepare these soaps quite neutral, or a trifle superfatted, containing the requisite proportion of water to form a standard commercial article and many of the so-called "marine soaps" are so formed. These soaps when made from the coconut oil group are soluble in salt water and thus their name. However it is fairly obvious that in a process of this kind the glycerol content of the oil is lost which seriously bars this method of soap making from competing with the "boiled" soaps in spite of the low initial cost of the plant. At first glance it would appear that this cold process would be the ideal one for the combination of caustic soda with the "*free fatty acids*" but it is found in practice that lumps of soap from which occlude the fatty acids and that it is possible to have a cold process soap made from free fatty acids and caustic soda in which both the base and the acid are lying together in an uncombined condition.

(*To be continued*)

Fish Meal a Growing Industry

HAVING its origin in the war-born desire to conserve, the fish meal industry today is steadily growing and assuming an important place in the animal food trade. Norway ranks first in production, having more than 100 factories, and the United States is second with plants operating along both the Atlantic and Pacific coasts.

The disposal of fish refuse has always been a problem among fishermen. Every net load brought to the surface by them contains many varieties not suitable for man, and of those that find their way to the markets of the world, about forty per cent is waste. Before the war this large supply of refuse was reduced to fertilizer, but through the impetus to conserve created during that time, ways were found to prepare it for feeding to animals.

From storage tanks or ships' holds the fish that supply Norwegian factories are carried in a series of cups on an endless chain into boilers where they are sprayed with steam. A conveyor pulls them through the boiler and from the other end they emerge as a warm pulp. This is pressed and dried and ground into meal. In another process the fish are salted, allowed to season for ten days and then cooked by steam and pressed into cakes. These are broken up and dried in heated cylinders and later ground fine and sifted.

Although Norway and the United States are the largest producers of fish meal, Germany is the greatest user, feeding 100,000 tons a year to swine. The meal is given in large quantities to young pigs, the amount being decreased as the animals grow older and being discontinued entirely a few weeks before slaughtering. This method of feeding is necessary to prevent the meat from having a fishy flavor.

Miss Walker Joins Bureau

Miss Geraldine Walker, formerly research associate for the American Oil Chemists' Society at the U. S. Bureau of Standards, became a regular employee of the Bureau on July 2. Miss Walker is expected to continue with her work on the standardization of Lovibond glasses.

1928-29 A. O. C. S. Committees Announced

MR. A. W. Putland, president of the American Oil Chemists' Society, has selected the personnel of all Society committees for the coming year except one. There are twelve committees, as compared to thirteen last year, and the range of subjects covered is slightly different than under the regime of Mr. H. P. Trevithick, the preceding president.

New committees this year are the one to further study the method of determining oil in cotton seed, and the one to investigate the value of the Kreis test as an index to the degree of rancidity. Past committees that have been abolished because of completed work are the prize awards committee for OIL AND FAT INDUSTRIES articles, the ammonia committee, the committee to investigate the Dubosq calorimeter, the analysis of commercial oils and fats committee, and the basic research committee.

New Committees

The 1928-29 committees are as follows: Governing Committee: A. W. Putland, chairman, H. P. Trevithick, W. R. Stryker, J. J. Vollertson, R. H. Fash, H. J. Morrison, W. H. Irwin, G. K. Witmer.

Referee Board: W. H. Irwin, chairman, A. W. Putland, Felix Paquin, L. C. Haskell, H. Aspegren.

Smalley Foundation: H. C. Moore, chairman, H. B. Battle, C. A. Butt, L. B. Forbes, M. G. Boulware, E. H. Tenent.

Uniform Method and Planning Committee: J. J. Vollertson, chairman, H. J. Morrison, C. B. Cluff, N. C. Hamner, B. H. Thurman.

Detergent Committee: This committee is not complete at present. However, L. T. Howells, who served as vice-chairman of the committee last year has consented to act as chairman this year. The balance of the committee will be complete in a short time.

Membership Committee: W. R. Stryker, chairman, H. P. Trevithick, P. McG. Shuey; J. P. Harris, P. W. Tompkins.

Refining Committee Members

Refining Committee: C. B. Cluff, chairman, W. R. Stryker, R. H. Fash, R. C. Hatter, E. R. Barrow.

Committee To Further Study Method of Determining Oil in Cotton Seed: C. H. Cox, chairman, E. C. Ainslie, W. D. Hutchins, R. H. Fash, D. C. Picard.

Committee on Crude Mill Operations: A. K. Schwartz, chairman, J. J. Ganucheau, Lehman Johnson.

Committee to Investigate the Value of the Kreis Test as an Index to the Degree of Rancidity: A. S. Richardson, chairman, Dan Gray, A. K. Epstein, C. H. Bailey, Rosalind Norris, L. M. Tolman, W. D. Hutchins, G. S. Jamieson.

Color Committee: W. D. Hutchins, chairman, A. K. Schwartz, G. L. Grant, G. W. Agee, L. G. Copes.

Moisture Committee: W. H. Irwin, Chairman, E. H. Tenent, E. W. Magruder, N. C. Hamner, W. D. Evans.

The Composition and Toxic Effects of Gossypol

BY E. P. CLARK *

U. S. Dep't of Agriculture, Washington

GOSSYPOL is a peculiar phenolic body which, as far as is known, occurs only in the cotton plant. The substance possesses many characteristic chemical properties that give it a unique academic interest. From the practical standpoint, also, the substance is important, as its toxic properties are conceded to be responsible for the so-called cottonseed injury which results from the feeding of large quantities of cottonseed meal to livestock (1). This injury constitutes a problem of considerable economic magnitude, the solution of which will eventually involve a method for detoxifying cottonseed meal. In the past an intelligent approach to such an endeavor has been greatly hindered by the lack of specific information regarding the chemistry of gossypol. In order to overcome this difficulty, if possible, a new chemical study of the substance was undertaken a little over a year ago. The purpose of this report is to give an outline of the results of this work. Before presenting the report, however, a summary of the chemical work previously done upon gossypol will be given in order to acquaint the reader with the status of the problem at the time this investigation was undertaken.

Undoubtedly gossypol was first prepared in a fairly pure condition by Marchlewski (2) in 1899. His preparation contained loosely bound acetic acid and had a melting point of 188°C. He reported analyses of a number of samples, but he was not able to establish with certainty a molecular formula although $C_{13}H_{14}O_4$ or $C_{32}H_{34}O_{10}$ was suggested. He made no crystalline derivatives of the material but showed that it was not a glucoside and that in all probability it contained no alkoxyl groups. He recorded some color reactions and its behavior toward certain reagents.

Carruth's Investigations

No further outstanding chemical work was published upon the subject until Carruth (3) communicated his interesting results in 1918. This investigator reported improvements in the preparation of gossypol, thus making possible more extended studies. As a result of his investigation he concluded that gossypol is a phenolic substance, having the formula $C_{30}H_{30}O_9$ or $C_{30}H_{28}O_9$. When the material was crystallized from acetic acid it contained one molecule of loosely bound acid which could be removed by dissolving the substance in ether, adding water, and then removing the ether by evaporation. The acetic acid remained in the water and could be titrated. In this way a value near 532 was obtained for its molecular weight. Determinations of this constant by physicochemical methods were not conclusive. Values ranging from 300 to 595 resulted by the use of different methods and solvents. When gossypol was dissolved in

*Read before the Annual Meeting of the American Oil Chemists' Society, New Orleans, La., May 14-15, 1928.

aniline, or when gossypol and aniline were dissolved in an appropriate solvent, a characteristic crystalline product was formed. Carruth assumed the compound to have the formula $C_{30}H_{28}O_8.2C_6H_5NH_2$. No carbon or hydrogen figures were given on this material, but those for nitrogen were reported to be from 3.97 to 4.84 per cent. Crystalline acyl derivatives of gossypol were not obtained, but analysis of the amorphous acetyl derivative indicated the presence of four acetyl groups. When gossypol was heated to its decomposition point a new substance called *B* gossypol was formed. This was obtained crystalline and apparently represented gossypol less two mols of water.

Further Work Desirable

The work of Marchlewski and of Carruth constitutes essentially all that was recorded concerning the chemistry of this interesting substance at the time the present investigation was undertaken; but a critical study of their findings indicated that reexamination of the data given was desirable. A quantity of gossypol was therefore prepared and purified (4). The results obtained upon this material indicated that the molecular formula for gossypol is $C_{30}H_{30}O_8$. This formula differs from Carruth's, but, in the light of the experience gained in the purification of the substance, it seems doubtful whether his material was entirely pure. A reddish brown impurity was associated with all the gossypol prepared by Carruth's method that was removed only with great difficulty by a large number of solvents suitable for its recrystallization. A combination of solvents that gave the desired result was eventually found, but again difficulty was encountered in obtaining the material free from the solvent used in its purification. In a number of cases, a small indefinite amount of solvent remained with the crystals. This could not be removed in a 0.1 mm. vacuum over both sulfuric acid and potassium hydroxide at temperatures which would insure the integrity of the substance. Several solvents were found, however, which under certain conditions gave material having uniform composition. The method used to verify this was to obtain from different solvents preparations that gave check analyses. When this was accomplished, carbon and hydrogen figures were obtained which indicated the formula given above. Various derivatives, prepared from the purified gossypol, also gave values upon analysis which checked the formula indicated. Among these were the so-called "acetate," i.e., gossypol + one molecule of acetic acid, anhydrogossypol (Carruth's B gossypol), the aniline condensation product, the dioxime, and a hexaacetyl derivative.

Molecular Weight Studies

The analytically pure gossypol was a bright canary-yellow crystalline substance with a melting point of 214° (corrected). In solution no optical activity was exhibited. Molecular weight determinations by the camphor method of Rast (5) gave results of the order required for the formula suggested. Also, the acetic acid in the so-called acetate was found to be 10.51 per cent, which gave a molecular weight of 511 for gossypol, if it is assumed that one mol of the latter is associated with one mol of acetic acid. Gossypol was soluble in ether and acetone, but only sparingly soluble in other

common organic solvents. It was insoluble in water, but dissolved readily in dilute ammonia and sodium carbonate. It was soluble in aqueous fixed alkalies; but when dissolved in an excess of alkali it slowly decomposed, forming a brown solution which gradually became a beautiful purple. However, when potassium hydroxide was added to an aqueous suspension of finely ground gossypol, in amounts slightly more than enough to cause complete solution, the excess alkali could be titrated and the acid value of the substance was thus determined. If it is assumed that two equivalents of potassium hydroxide were used, molecular weight values of 505 and 507 were obtained. Gossypol dissolved in concentrated sulfuric acid formed a deep scarlet colored solution.

Anhydrogossypol

Upon diluting this acid liquid with water, the gossypol was thrown out unchanged. It was readily soluble in saturated methyl alcoholic hydrochloric acid. At first the color of the solution was brown, which gradually turned deep green and finally intense blue. When heated to its melting point, gossypol lost two mols of water, producing a new crystalline body, anhydrogossypol, $C_{30}H_{26}O_6$. This material possessed markedly different solubilities, but still retained the characteristic color reactions of the original material. Oximation of gossypol produced a colorless dioxime, which seemed to indicate that the chromophores are quinone groups. As stated by Carruth, gossypol combined with aniline to form a deep orange-colored crystalline compound. This substance was found to be a condensation product formed by one mol of gossypol uniting with two mols of aniline, with the elimination of two mols of water. Its formula was found to be $C_{42}H_{40}N_2O_6$, and it is probably a Schiff base type of compound.

Results of Acetylation

Acetylation of gossypol was carried out with acetic anhydride, with the use of sodium acetate and also pyridine as catalysts. With sodium acetate, by employing the conventional proportions of reagents (one part of acetate, four parts of substance, and sixteen parts of acetic anhydride) and by boiling the mixture for ten minutes, a non-crystallizable product was obtained which analyzed for 30.8 per cent acetyl. But when a large excess of the reagents was used and the boiling was continued for two hours, a material resulted, about ten per cent of which was obtained as beautiful crystalline plates. Acetylation in pyridine solution gave the same product but the yield was larger. This substance, when analyzed for acetyl by Perkins' method (6) for O-acyl compounds, gave from 24.9 to 25.9 per cent acetyl. These figures agreed well for a tetraacetyl gossypol (25.07 per cent). Carbon values, however, were those of a hexaacetyl body. It was then found that if Perkins' method (6) for N-acyl compounds was used, the percentage of acetyl required for a hexaacetyl derivative was obtained. The crystalline material was therefore a hexaacetyl gossypol, indicating that in the parent substance there were six hydroxyl groups. Thus all the oxygen in gossypol has been accounted for. Two atoms are present as carbonyl groups, as was shown by the formation of a dioxime, and six are present as hydroxyl groups. It is to be emphasized, though, that two of these hydroxyl groups behave differently from the remaining

four. This was manifest by the drastic treatment necessary to remove the last two acetyl groups, and also by the fact that two hydroxyl groups are capable of being titrated as an acid.

In the course of the purification of the substance it seemed desirable to determine the approximate toxicity of the analytically pure gossypol as well as some of the less pure preparations being dealt with. The results are recorded in Table I. In this work certain observations were made which have not hitherto been recorded, but which seemed to be of sufficient interest to warrant reporting.

White rats, whose average weight was 190 gm., were injected intraperitoneally with cottonseed oil solutions of the various preparations.

There was no apparent difference between the toxicity of the crude gossypol acetate and the analytically pure gossypol. Rats receiving doses of twenty mg. or more per kilo of body weight died in from twenty hours to thirteen days. Of those receiving from ten to twenty mg. per kilo, fifty per cent died in from two to eighteen days; the remaining fifty per cent survived. Though the percentage of deaths at fifteen mg. per kilo equals that at twenty mg. per kilo, death resulting from the latter dosage was the result of acute poisoning, whereas death at fifteen mg. per kilo was the result of chronic poisoning.

Postmortem findings in the acute type of poisoning were oily droplets and plaques in the peritoneum, congested lungs, hemorrhagic condition of all the viscera, and cardiac dilatation. In the chronic type of poisoning the outstanding indication was intestinal impaction. The cause of delayed death was stated by Dr. Formad, pathologist of the Bureau of Animal Industry, "to be probably due to a paralyzing effect upon the sympathetic nervous system." Dr. Formad further stated that "it seemed probable that there was a tonic spasm of the sphincter ani accompanied by general decreased intes-

TABLE I

Toxicity Tests Made Upon Different Preparations of Gossypol

The material, dissolved in cottonseed oil, was given intraperitoneally to white rats, the average weight of each being 190 gm.

Material Used	Dose, Mg. Per Kg.	No. of Rats Used	No. of Deaths Resulting	Time in Days Until Death	Remarks
Crude gossypol acetate	25	1	0	0	
	50	2	2	2, 2	Acute
	100	1	1	1	Acute
Gossypol recrystallized from chloroform	25	2	2	6, 13	
	50	2	2	2, 2	All but 13 day animal acute
	75	2	2	1, 1	
	100	2	2	1, 1	
Gossypol twice recrystallized from ether and petroleum ether	20	2	2	7, 10	
	30	2	2	3, 5	All acute type
	40	1	1	3	
	50	1	1	1	
Purified gossypol recrystallized from ether (analytically pure)	10	6	2	17, 18	2 day and 3 day animals acute, all others, chronic
	15	6	5	10, 11, 12, 12, 13	
	20	6	5	2, 3, 9, 10, 10	

tinal tonus which led to decreased rate of elimination of feces and finally to an intestinal impaction. This latter, in turn, produced pressure upon the diaphragm which was transmitted to the heart and lungs and served as a probable cause of death."

Condition of Gossypol in Cottonseed Meal

The molecular formula of gossypol and its approximate toxicity having been determined, attention was next directed to the condition of the bound gossypol in cottonseed meal (7). As is well known among those interested in the cottonseed meal problem, the cooking and pressing processes to which cottonseeds are subjected in the manufacture of cottonseed oil exert a profound change in the condition of the gossypol originally in the raw kernels. Gossypol is readily extracted from the raw seeds with solvents such as ether or acetone. When cottonseed meal is treated in the same manner, however, the quantity of gossypol obtained is much less than that extracted from the raw kernels, although little or none of the substance is present in the expelled oil (8). Coincident with the diminution of extractable gossypol, the toxicity of the meal as compared with that of the untreated seeds becomes much less (3, 8, 9, 10). Some investigators have explained this phenomenon as being due to a change in the gossypol molecule that is supposed to occur during the cooking and pressing process. Withers and Carruth (8, 9, 10) have advanced the idea that the reaction is mainly one of oxidation. The oxidized gossypol, which is considered to be non-toxic, or at least much less toxic than the parent material, has been called by Carruth (9) D gossypol. More recently Sherwood (12) has suggested that the transformation of gossypol to D gossypol is one of hydrolysis. In each case the assumption was made that D gossypol is an individual substance derived from gossypol through an alteration of the molecule of the latter. The support of this idea, however, rests upon indirect evidence only, as D gossypol has never been isolated. On the other hand, hot aniline extraction of cottonseed meal gives a crystalline material having the general appearance of dianiline gossypol. The substance has been considered a derivative of D gossypol and in the literature it is known as aniline D gossypol; but as no thorough analysis of it has been recorded, it has been impossible to arrive at any definite conclusions concerning its nature.

Condensation Products with Aniline

In connection with this phase of the gossypol problem, aniline D gossypol was investigated and found to be identical with dianiline gossypol which is obtained by condensing pure gossypol with aniline. The evidence upon which this statement is made is: The two substances have the same melting point, and no depression occurs when they are mixed. They possess the same optical properties. Their molecular weights are the same within the limits of experimental error. Their elemental composition is identical, and finally, upon hydrolysis of aniline D gossypol, a substance is obtained which is identical both chemically and physiologically with analytically pure gossypol. This evidence indicates that the gossypol molecule has undergone no chemical alteration, such as oxidation or

hydrolysis as suggested by the investigators mentioned before.

Bound Gossypol Hypothesis

Furthermore, the information materially simplifies the problem of the fate of gossypol during the cooking and pressing treatment and leads to a hypothesis concerning the mechanism of the process whereby gossypol becomes bound and is also rendered more or less physiologically inert. This hypothesis is as follows: During the heating and pressing to which the seeds are subjected the resin glands containing the gossypol are disrupted and possibly much of the gossypol is dissolved in the oil present. It thus comes in intimate contact with the proteins of the seeds and in this condition, favored by heat and pressure, probably condenses with free amino groups of the protein molecules, as it does with many primary amines, forming substances *similar in type* to the dianiline gossypol. The material is thus bound rendering it insoluble and as far as is known physiologically inert.* The work of Jones and Waterman (11), in which they found that peptic and tryptic digestion of casein and cottonseed globulin was reduced fifteen per cent when treated with one per cent gossypol, lends support to this idea.

Whether or not this explanation is correct, it can be stated definitely that the cooking and pressing processes used in the manufacture of cottonseed oil produce no chemical alteration in the gossypol molecule. In the light of this information it would seem desirable to discontinue the expression D gossypol, because of its generally accepted meaning, and substitute for it the term *bound* gossypol.

(To be continued)

*Withers and Carruth (10) advanced a somewhat similar view, suggesting that while most of the gossypol disappears by means of an oxidation process, some may become bound through condensing with amino and carboxyl groups of protein molecules. However, in Carruth's article upon the chemistry of gossypol (3) a statement is made which seems to indicate that he and Withers had subsequently abandoned this hypothesis.

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Refining Committee to Have Research Chemist

The Governing Committee of the American Oil Chemists' Society has placed a small sum of money at the immediate disposal of the Refining Committee to be paid as salary to a research chemist for further standardizing refining methods.

This announcement was made recently by Mr. A. W. Putland, president of the American Oil Chemists' Society.

Cotton Seed Crushers Develop Fair Trade Rules

Condemn Secret Deals and Urge Publication of Prices

TWO HUNDRED representatives of the cottonseed crushing industry met at the Peabody Hotel, Memphis, on July 24 to discuss and establish a code of business ethics. After an all day session the thirteen rules printed below were formulated. The conference was called by the Federal Trade Commission in response to an expressed desire to rid the industry of certain undesirable trade practices. The code developed is now in the hands of the Commission for final approval, but many oil millers are already completing deals in accordance with the principles set forth. Edgar A. McCulloch of Arkansas, member of the Federal Trade Commission, presided over the meeting and guided it in such a way that few changes in the rules are expected.

The resolutions adopted are as follows:

"The Cottonseed Oil Mill Industry believes that the oil mills, as the agency which buys the cottonseed and manufactures it into products of great value to mankind, fill a necessary and proper function in relation to a basic agricultural product, and are entitled to a fair return for such services. They owe a duty alike to the farmer who produces the seed and to the consuming public which buys the products thereof. That duty includes the obligation to pay a fair price for the raw material, to deal fairly with labor, to manufacture efficiently, to eliminate waste, to sell the products at a fair price, to develop new uses, to approve and encourage sound and fair trade practices and to condemn and prevent bad and unfair practices. In order to perform that duty, it is advisable to encourage proper and ethical principles in the industry, to the end that competition may be open and constructive, and not secret and destructive. With these purposes in mind the mills therefore declare that it is good practice in the operation of crushing cottonseed to abide by the following principles:

1. *Whereas*, there has been discrimination in the prices paid for cottonseed and in the prices charged for the products thereof, and

"*Whereas*, the Congress of the United States in passing the Clayton Act and many states by enacting statutes have condemned price discrimination, and

"*Whereas*, in order that the market value of cottonseed and its products may be known at all times by all who are interested, to the end that discrimination in prices may be prevented,

"*Resolved*, that it is hereby declared unfair competition either directly or indirectly to discriminate in the price paid to different sellers of cottonseed or the price charged for the products thereof when the effect of such discrim-

ination may be to substantially lessen competition or tend to create a monopoly: '*Provided*, That nothing herein contained shall prevent discrimination in the price paid to different producers of such commodities on account of differences in the grade, quality, or quantity of the commodity purchased, or that makes only due allowance for difference in the cost of purchasing or transportation, or discrimination in price in the same or different communities made in good faith to meet competition.'

"*Resolved Further*, That each mill shall by all available means publish immediately to the selling public the price paid for cottonseed and to the buying public the prices received for the products thereof, and the reporting of any false or fictitious prices, or the failure to report the exact price paid for cottonseed or price received for the products thereof is hereby declared an unfair method of competition.

2. "The price paid for cottonseed or charged for the products thereof is a matter of individual judgment to be determined by each unit concerned. No unit is or should be under obligation to change or maintain its prices to meet the wishes or views of any other unit or group of units.

3. "All contracts for the purchase of cottonseed should be for a specified tonnage at a specified price, and for the sale of products for a specified quantity at a specified price, entered into in good faith between buyer and seller and subject to no cancellation save for legal cause. The violation of the provisions of this Rule is hereby declared to be an unfair method of competition.

4. "Any contract post-dated or pre-dated, or entered into without authorization and definite commitment at the time it is made by both parties thereto, is an unfair method of competition.

5. "It is unfair competition and against public policy to buy and settle for cottonseed except on a basis of quality, cleanliness and moisture content. Sound, clean, dry seed are worth more than damaged or trashy seed or seed containing an excess of moisture.

6. "The payment or allowance to sellers of seed or buyers of the products thereof of commissions, bonuses, rebates or subsidies of any kind, confidential prices or the use of any device which does not include in the price paid or bid the entire consideration, is hereby declared an unfair method of competition in the form of commercial bribery. This section also applies to contracts for the exchange of manufactured products for cottonseed and no evasions or subterfuges can be practiced or included under such guise.

7. "It is unfair competition to store or receive cottonseed on call for the account of others, or to contract for or buy cottonseed for future shipment where such shipment is beyond fifteen (15) days from date of purchase.

8. "It is unfair competition to buy cottonseed in carload quantities except on weights and quality at mill destination.

9. "Brokerage, if any, should be paid by the seller.

10. "It is hereby declared to be an unfair method of competition to sell products which are not plainly and accurately described or branded and in full compliance with legal and trade definitions and requirements.

11. "*Whereas*, excessive commissions have been paid to seed agents for the purchase of seed,

which has resulted in such commissions being paid directly or indirectly to sellers of seed, the effect being the publication of fictitious prices for seed and the inability of the public to know at all times the actual market for cottonseed, therefore, be it

"*Resolved*, That where the practice of buying seed through commission agents is in existence, the payment of any amount in excess of $3.00 per ton on wagon seed and gin seed, such payment to include storage, handling, loading, loss in weight and all other charges of every kind, and the payment of any commission in excess of fifty cents per ton for buying carload seed is against public policy and hereby declared to be an unfair method of competition.

"*Resolved Further*, That the payment of such commission to other than bona fide seed buyers who render a service, and/or in such manner that any part of it goes to the seller directly or indirectly through the medium of partners, influential friends, kinspeople or under any other guise whatsoever is hereby declared to be against public policy and an unfair method of competition.

"*Resolved Further*, That the names of such 50c buyers be made available to the public.

12. "*Resolved*, That in order to conform to the principles of these rules a Uniform Purchase Contract and Account Sales form should be used in all transactions.

13. "The strict observance in good faith of all these Resolutions being to the best interest alike of the buyers and of the sellers of cottonseed and of the products of the mills, be it therefore

"*Resolved*, That the clandestine violation of any of said Resolutions, those accepted by the Federal Trade Commission merely as expressions of the industry, as well as those approved by said Commission, shall be deemed to be unfair methods of competition."

Smalley Foundation Check-Meal Samples

H. C. Moore, chairman of the Smalley Foundation Committee of the American Oil Chemists' Society, states that the weekly checkmeal samples of the Foundation for the year 1928-29 will be ready for distribution early next month. The plan of procedure, which has been used for the past several years, consists of thirty samples, one of which should be reported on each week beginning with September 24.

Participation in this collaborative analytical work is open to all members of the American Oil Chemists' Society. State and Federal chemists also are at liberty to participate, whether members or not, without being charged for the samples. Although the Smalley Foundation does not aim to provide a contest, but rather to improve the analytical standard, nevertheless, prize awards for the highest averages are given in order to create interest.

The check-meal samples will be prepared, as last year, by Thomas C. Law, of Law & Company, Atlanta, Ga. Further information can be secured from the chairman of the committee at 111 W. Jackson Blvd., Chicago, Ill., and society members can enroll with J. C. P. Helm, 705 Tchoupitoulas St., New Orleans, by paying fifteen dollars for the thirty samples.

Enlarge Seidner's Factory

Seidner's mayonnaise dressing plant at Westerly, R. I., is being enlarged to care for the manufacture not only of mayonnaise but also of horseradish and mustard.

Book Reviews

FATS AND OILS STUDIES OF THE FOOD RESEARCH INSTITUTE: NUMBER 2, COPRA AND COCONUT OIL. By Katherine Snodgrass, 8vo. Stanford University Press, Stanford University, California.

The Directors' Preface to this book very clearly sets forth the material which is presented, its scope and limitations.

The book deals entirely with the economic phases of the production and utilization of copra and coconut oil. It comprises a clear concise treatment of these foodstuffs purely from the economic viewpoint. Such a work can, without effort, be written in such a way as to make laborious reading. This emphatically is not the case with "Copra and Coconut Oil."

The world production of copra and coconut oil is treated in a general way. Separate chapters are then devoted to discussions of the production in Ceylon, India, and the Malay States; Dutch East Indies, and Oceania; and the Philippine Islands. Particular emphasis is placed on the production and trade in the Philippines and the conditions there as they affect copra, and more especially coconut oil.

Shipping and tariff conditions, the volume, and relative amounts of the international trade in these commodities are discussed in detail.

The position of copra and coconut oil in the markets of the world is carefully treated, as is also the outlook for the future.

The author seems to feel that it is "impossible to say" whether or not coconut oil is responsible for the demand for white soaps. It seems to the reviewer that a logical explanation for this demand is that, due to the immigration laws, the American housewife has difficulty in getting household help. She therefore has to do her own laundering, and, being naturally neat and dainty, desires a white soap.

Although the author is frequently called on to generalize from meagre economic data, there are a few places where she does not express her own opinion upon matters where it is desirable. For instance, she does not offer to arbitrate strongly on the question of whether or not it is better to harvest the coconuts by removing them from the trees, or gathering them after they have ripened and fallen to the ground.

Despite the fact that there are a few places in this work where the coconut is given "the benefit of the doubt," it is a very valuable book for all who are in any way concerned with the coconut and its products. Much of the information undoubtedly will be of great value to the investor in these commodities.

It is heartily recommended that all those connected with the coconut industry in any way thoroughly familiarize themselves with this book and its contents. The same applies to all of those who consider making such connection.

Much painstaking effort has obviously been expended in order to offer this work to the public.

JOHN E. RUTZLER, JR.

The American Oil Chemists' Society

Notes and Correspondence

Standardization of Lovibond Glasses

(Investigation by the Bureau of Standards in Cooperation with The American Oil Chemists' Society.)
Report for June, 1928.

By Irwin G. Priest

I. *Investigation of Sixty-five 35-Yellow Glasses Submitted by A. O. C. S., August, 1927. (Priest, Gibson, Judd, Walker, Brown, Riley.)*

The preparation of the report on this investigation which has been pending for several months and frequently set aside because of other work, has been notably advanced. Previous conclusions have been carefully reviewed and tested. The "practical equivalent" mentioned in the report for March ("Oil and Fat Industries" p. 152, May, 1928) has been found to be misleading. The following advance abstract of the report now being prepared for publication summarizes the essential results of this investigation:

Abstract

This report deals with sixty-five nominally 35-yellow Lovibond glasses collected from members of the American Oil Chemists' Society, submitted to the Bureau of Standards in August, 1927, by Mr. H. P. Trevithick, and identified by A. O. C. S. numbers engraved on the glasses. It is understood that Mr. Trevithick has a key to these numbers showing the ownership of each glass.

The fundamental standard to which the values here reported are referred is contained implicitly in a particular set of glasses originally obtained directly from the Lovibond establishment (The Tintometer, Ltd.) in 1912, and now kept at the Bureau of Standards and designated as B. S. 9940 for purposes of identification. The units of the red and yellow scales effective in the present calibration are as derived from this set of glasses by Priest and Gibson in 1927 after adjusting the inconsistencies among the different glasses in the set.

The data reported include, for each glass:

(1) The equivalent in terms of Lovibond yellow and red.

(2) The sunlight transmission.

Data on 7 Glasses

Explicit directions are given for using the equivalents in practice. Special comments are made on seven glasses having strikingly abnormal transmissions or badly marred surfaces. Also, to aid in the possible identification of the origin of the glasses, detailed information is given as to engraved marks found on the glasses, thickness of the glasses, and character of the edges.

The average equivalent for all of these glasses is 32.3 yellow, 0.17 red. The average sunlight transmission is 3.5 per cent higher than the transmission adopted as standard for 35 yellow. It is, however, only 0.6 per cent higher than the standard transmission proper to the average yellow

numeral (32.3) found for these glasses, which shows, that in the average, the given data for sunlight transmissions and yellow scale numerals are in perfect accord. The maximum errors found in the collection are:

Yellow numeral, about 7.

Red numeral, about 0.3.

Sunlight transmission, about 14 per cent.

Sunlight Transmissions Vary

The sunlight transmission of one of the glasses (A. O. C. S. 125) is quite remarkably higher (12 per cent) than the standard transmission for 35 yellow. The sunlight transmissions of six glasses (A. O. C. S. Nos. 27, 31, 41, 97, 125, 131) depart notably (9 per cent to 14 per cent) from the transmissions proper to the yellow numerals assigned to them in this calibration.

It is clear that the average equivalent of these sixty-five glasses is not in *precise* accord with the standard 35 yellow derived by Priest and Gibson from the Bureau of Standards set (B. S. 9940) obtained from the Lovibond establishment. On the other hand, the discrepancy is certainly not more than two or three times the least difference perceptible with certainty by the best observers under the most favorable conditions of observation. The idea occurs that it might seem reasonable to adopt the average as standard instead of the standard which has been adopted. There are, however, grave objections to this proposal which space forbids discussing here. Moreover, the difference is so trivial that the discussion would hardly be worth while.

Of course, if *their own average* were taken as standard instead of the standard arbitrarily adopted, the "errors" for most of the glasses would be notably decreased. With a very few possible exceptions, the *uniformity* of these glasses is quite as good as could be required or expected in order *to comport with the purposes and methods of use for which they were intended by the makers*. The irregularities found and reported here have only been discovered by methods of observation greatly exceeding in sensibility and accuracy the methods of color matching contemplated by the makers, and the methods actually used by the oil chemists in grading oils.

Three Glasses Marred

The surfaces of three glasses (A. O. C. S. Nos. 41, 97, 119) were so badly marred that it might seem advisable to discard them. With the possible exception of these badly marred glasses, all of the glasses are considered fit to be regarded as equivalent to standard 35 yellow *under the present customary conditions of grading oils*. The point to this recommendation is not that the glasses are perfect from the point of view of precision calibration, but that the errors found are neglibible in comparison with the uncertainties inherent in the customary methods of using the glasses. When more reliable and precise methods of grading are adopted, it will be in order to consider using the precise equivalents which are given for each glass. Of course, even under present conditions, the glasses which approach more nearly standard 35 yellow may perhaps be regarded with somewhat greater satisfaction and respect by those who use them. The de-

tailed data given in Table 1 of the report will enable such glasses to be identified.

An outstanding result of this investigation is that the discrepancies of color grading which have troubled the oil trade can not be charged to lack of uniformity among the 35-yellow glasses. The sources of these troubles are rather to be sought in the following factors:

(1) Unstandardized, non-uniform, and insensitive methods of comparing the oil samples with the glasses.

(2) Grading of oil by observers having abnormal color sense or low power of hue discrimination.

(3) Errors in the red glasses.

Collection Fair Sample

It seems just to assume that this rather large collection of glasses constitutes a fair sample of 35-yellow glasses issued by the Lovibond establishment and in use in the oil trade in the United States. If this be admitted, it seems superfluous to test individual 35-yellow glasses further under present conditions. The chance of finding one with an error great enough to be of consequence in comparison with the other uncertainties just mentioned is very small. After the above mentioned sources of error have been eliminated in practice, it will be due season to reconsider the calibration of 35-yellow glasses if it then appears necessary. In the meantime, it may well be considered legitimate to accept on faith the 35-yellow glasses as issued by the Lovibond establishment.

II *Effect of Temperature Change on Color of Red and Yellow Lovibond Glasses.* (Cf. Report for February and March.)

The paper describing this investigation has been prepared and is now in the stage of final revision for publication. The following advance abstract summarizes the essential content of this paper.

Abstract

The spectral transmission at twelve wave lengths in the visible spectrum of two Lovibond glasses (35Y and 7.2R) has been carefully determined at 15°c and at 40°c. From this spectral transmission data the color change corresponding to the temperature interval of twenty-five centigrade degrees has been computed. It was found, both for 35Y alone and for the 35Y + 7.2R combination, that an increase of twenty-five centigrade degrees is the practical colorimetric equivalent of adding 0.2 in Lovibond red units. This difference is almost negligible in the color-grading of cottonseed-oil.

Preliminary work on two samples of cottonseed-oil indicates that the oil changes in color with change in temperature even less than the glasses do. If all oils behave like these two samples, only extreme variations (more than 15 centigrade degrees) in temperature need be taken into account in color-grading cottonseed-oil with Lovibond glasses. (Judd).

III. *Tests of Color Sense Conducted for the American Oil Chemists' Society at New Orleans.*

Preparation of the report describing the results of these tests is in progress. The results obtained at New Orleans are being reduced and summarized. Tests similar to those at New Orleans have been made on seven observers at the Bureau since the Con-

vention, and in addition, the effect of practice and coaching has been studied. A test has also been made with a red-green blind observer. These results will all be incorporated in the report on this work. (Priest, Judd, Walker).

IV. *Spectral Transmission Measurements on Oils Graded at New Orleans Convention.*

As a record of the colors of the oils graded in the tests at New Orleans, spectral transmission measurements have been made. (Gibson, Brown).

V. *Progress on Routine Calibration of Red Glasses Submitted by A. O. C. S.*

One red glass submitted May 18th has been graded, reported and returned. (Date of report, June 13th. Date of shipment to Mr. Putland, June 8th.)

Twenty-five red glasses, submitted May 31st, have been graded, reported and returned. (Date of report, June 21st. Date of shipment to Mr. Putland, June 18th.)

Twenty-five red glasses submitted June 14th, have been graded, reported and returned. (Date of report, June 25th. Date of shipment to Mr. Putland, June 21st.)

Twenty-four red glasses submitted June 25th, have been graded. The glasses and reports will be sent in a few days.

One glass submitted June 25th (in addition to those mentioned above) was found to bear the same number as another glass previously reported (A. O. C. S. 441). It has been graded but is being held for the assignment of a different A. O. C. S. number.

The total number of red glasses graded (first lot submitted January 16, 1928) has been 295. (Walker).

VI. *Corrections.*

The printing of the April Report (Oil and Fat Industries, pp. 184-188, June, 1928) contains a great many typographical errors, which it does not seem feasible to correct by a mere list of errata.

In the report for May, first line, under b, first column of page 220, Oil and Fat Industries, July, 1928, N″ should be N‴.

VII. *Termination of Service of A. O. C. S. Research Associate at the Bureau of Standards.*

Miss Geraldine K. Walker, A. O. C. S. Research Associate at the Bureau since September 12, 1927, terminated her service in this capacity and became a regular Bureau employee on July 2, 1928. It is expected that Miss Walker will continue work on the investigation and calibration of Lovibond Glasses.

New Material for Thermometer Lines

A NEW material, consisting of a pasty mixture of water glass and finely divided manganese dioxide, has been developed by P. T. Hannen and H. D. Bruce of the U. S. Bureau of Standards for coloring the lines and figures on etched stem thermometers. It is claimed that a thermometer treated with this material retains its color even when heated to 500 degrees C. and that it can be used in hot oil, water or steam without affecting the visibility of the lines. Clinical thermometers, when treated with this new material, withstand common antiseptic solutions successfully, but the ability of the material to resist attack by acids and alkalis has not been fully determined. Pigments other than manganese dioxide can be mixed with water glass to secure other colors.